

AMENDMENTS TO THE SPECIFICATION:

Page 1, please add the following new paragraphs before paragraph [0001]:

[0000.2] CROSS-REFERENCE TO RELATED APPLICATIONS

[0000.4] This application is a 35 USC 371 application of PCT/JP 2004/012093
filed on August 24, 2004.

[0000.6] BACKGROUND OF THE INVENTION

Please replace paragraph [0001] with the following amended paragraph:

[0001] ~~TECHNICAL FIELD~~ **Field of the Invention**

Please replace paragraph [0003] with the following amended paragraph:

[0003] ~~BACKGROUND ART~~ **Description of the Prior Art**

Please replace paragraph [0004] with the following amended paragraph:

[0004] **In known thixocasting processes** ~~Thixocasting process~~, in which semi-molten billets[[,]] ~~in such a state as~~ **in which iron in both the** solid and liquid phases coexist, formed by heating cast iron, are injected into a mold constituted from dies[[,]] **. This process** is capable of manufacturing ~~a part that has~~ **parts having** a smaller wall thickness and more ~~complicated~~ **complex** shape than are possible with the conventional iron casting processes. The thixocasting process can manufacture a part near net shape that has substantially no casting defects such as shrinkage cavity, and is therefore regarded as a promising new iron casting method.

Please replace paragraph [0006] with the following amended paragraph:

[0006] There has also been such a technical problem that the thermal load on the die may cause melting loss and/or cracks when casting semi-molten cast iron that is a material of high

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melting point. The melting loss and/or cracks in the die tend to occur at the end of an injection path that runs from an injection sleeve to a mold cavity, namely at a gate provided at the entry of the cavity. These defects have been a factor that governs the service life of the dies and requires much time for repairing the dies.

Page 2, please replace paragraph [0007] with the following amended paragraph:

[0007] ~~There is a process of thixocasting for~~ **Thixocasting of** aluminum ~~[[or]]~~ **and** other material **are known** where a gate is provided to prevent scale from mixing in the casting.

Please replace paragraph [0009] with the following amended paragraph:

[0009] ~~Patent Document 1:~~ Japanese Unexamined Patent Publication ~~[[No.]]~~ **Nos. 8-300126; and 9-220656; and 2003-73768 disclose known thixocasting processes.**

Please delete paragraphs [0010] and [0011].

Please replace paragraph [0012] with the following amended paragraph:

[0012] ~~DISCLOSURE OF THE INVENTION~~ **SUMMARY OF THE INVENTION**

Please delete paragraph [0013].

Please replace paragraph [0014] with the following amended paragraph:

[0014] In case a thixocasting apparatus of slide gate system is applied to cast iron ~~that is a~~ material of **having a** high melting point, however, the high temperature tends to cause melting loss and/or cracks of the gate that may require frequent repairing of the die, or cause such a trouble that it becomes difficult to open/close the slide gate due to thermal strain.

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Page 3, please replace paragraph [0015] with the following amended paragraph:

[0015] Accordingly, an object of the present invention is to provide an apparatus for and a method of thixocasting a cast iron, that can effectively prevent the scale from mixing in the casting ~~[[()]]~~cavity~~[[()]]~~ thereby to obtain sound iron castings having good mechanical properties, by employing a system different from the slide gate system of the prior art.

Please delete paragraph [0016].

Please replace paragraph [0017] with the following amended paragraph:

[0017] After various experiments and studies conducted in order to achieve the object described above, the present inventors have completed the invention of an apparatus for thixocasting a cast iron that employs a system **which will be referred to as an** called insert system, ~~instead of the~~ **to replace the known** slide gate system. In the insert system, a plurality of gate members that are independent components are prepared as the gate, and are disposed at a cavity position every time injection casting is carried out. The gate member becomes inserted in the casting.

Page 4, please replace paragraph [0023] with the following amended paragraph:

[0023] According to the apparatus for thixocasting a cast iron of the second aspect, since the gate is formed to have a **projecting portion or** shape around the gate hole facing **and projecting into** the injection path to a certain extent, at least the scale on the ~~circumference~~ **surface** of the injected material that is pressed against the gate ~~[[is]]~~ **and** located outside the projecting portion~~[[,]]~~ ~~[[and]]~~ is left behind without being injected through the gate hole into the cavity.

Page 5, please replace paragraph [0024] with the following amended paragraph:

[0024] The term “certain extent” means such an extent around the gate hole as at least the scale formed on the circumference of the injected material is located at a position sufficiently far from the projecting portion. The projecting portion ~~[[is]]~~ preferably ~~protrude by~~ **protrudes at least about** 2 mm ~~or more~~.

Please replace paragraph [0025] with the following amended paragraph:

[0025] According to the method of thixocasting a cast iron of the third aspect, since the injected material is covered on the ~~circumference~~ **surface** thereof with a thin steel sheet that has a melting point higher than that of the injected cast iron, the injected material is prevented from straining when heated into semi-molten state. There is also such an advantage that less scale is generated when heated into semi-molten state. Thickness of the thin steel sheet is **preferably** within the range ~~of~~ from **about** 0.2 to **about** 0.5 mm, because the effect of preventing the injected material from straining when heated into semi-molten state cannot be obtained when the thickness is less than 0.2 mm, and the thin steel sheet cannot be folded up well during the pressured injection operation and filling failure may result when the thickness is more than 0.5 mm. The thickness is preferably in a range from 0.2 to 0.3 mm.

Please delete paragraph [0027].

Please replace paragraph [0028] with the following amended paragraph:

[0028] According to the apparatus for thixocasting a cast iron ~~of claim 1~~, although the same number of the gate members are required as the number of castings to be made, since the gate is disposed at the entry of the cavity every time injection casting is carried out, the gate that receives the highest thermal load is replaced for each injection casting operation. As a result,

melting loss and cracking of the gate can be prevented unlike in the slide gate system of the prior art.

Page 6, please replace paragraph [0030] with the following amended paragraph:

[0030] In addition, since the die structure can be substantially simplified, the present invention is free from ~~such a problem of the~~ **the problems of** slide gate ~~system that systems~~ **in which** the slide gate becomes difficult to open and close due to thermal strain.

Please replace paragraph [0032] with the following amended paragraph:

[0032] ~~According to the apparatus for thixocasting a cast iron of claim 2, in addition to the effect of the constitution of claim 1, since~~ **Since** the gate **of the present invention** has a projecting portion formed to a certain extent around the gate hole facing the injection path, most of the scale located at the distal end of the injected material such as a billet can be caused to stay in the space around the projecting portion. Also the presence of the projecting portion generates a force that presses the entire injected material against the circumference, so that the scale can be prevented from mixing on the circumference of the injected material. That is, the scale of the injected material can be effectively prevented from mixing into the **die** cavity ~~(casting)~~.

Please replace paragraph [0033] with the following amended paragraph:

[0033] ~~According to the method of thixocasting a cast iron of claim 3, since~~ **Since** the injected material is **preferably** covered on the circumference thereof by the thin steel sheet that has a melting point higher than that of the injected cast iron, the injected material is prevented from straining when heated into semi-molten state. When a part of relatively large

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size is cast, in particular, it is necessary to use the injected material such as a billet of a size that matches the size of the part to be cast and, accordingly, the injected material (billet) becomes more likely to ~~strain~~ **be strained** by gravity as the injected material becomes larger. Thus it is not preferable to ~~subject the~~ **employ** semi-molten injected material that has **become** strained to **a** thixocasting process, since it causes the entrapment of scales.

Please replace paragraph [0034] with the following amended paragraph:

[0034] Also by covering the injected material on the circumference thereof by the thin steel sheet that has a melting point higher than that of the injected cast iron, generation of the scale can be reduced when the injected material is heated into **the** solid-liquid phase.

Please replace paragraph [0036] with the following amended paragraph:

[0036] ~~Brief Description of the Drawings~~

BRIEF DESCRIPTION OF THE DRAWINGS

Please add the following new paragraph after paragraph [0036]:

[0036.5] The foregoing and other features and advantages of the invention will become apparent from the description contained herein below, taken in conjunction with the drawings, in which:

Page 8, please delete paragraph [0039], including the complete reference numeral list.

Page 9, please replace paragraph [0040] with the following amended paragraph:

[0040] ~~BEST MODE FOR CARRYING OUT THE INVENTION~~

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Please delete paragraph [0041].

Please replace paragraph [0042] with the following amended paragraph:

[0042] With reference to Fig. 1, the apparatus comprises a pair of **dies including** a movable die 10 and a fixed die 20, a plunger 30 and a sleeve 40 that constitute injection means and a gate 50.

Please replace paragraph [0043] with the following amended paragraph:

[0043] The movable die 10 has a recess in the surface thereof that makes contact with the fixed die 20, **with** the recess **making providing** a cavity 60 **to be filled**. The movable die 10 has ejector pins 70 inserted therein for ejecting the casting the casting out of the die after casting.

Please replace paragraph [0045] with the following amended paragraph:

[0045] The plunger 30 moves back and forth in the injection path 80, so as to push the semi-molten billet B that is the injected material forward as it advances, so as to fill in the cavity 60 with a **pressure pressurized casting material** via the gate 50.

Page 10, please replace paragraph [0048] with the following amended paragraph:

[0048] The gate may be made of, for example, spheroidal graphite cast iron, but may also be made of various low-cost metallic materials as long as the material would not be melted by the heat of the injection casting process. Ceramics may also be used. Since the gate 50 is **replaced** every time injection casting is carried out, the material is required to be of low cost. In addition, such a material that is not susceptible to melting loss and

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cracking, and is suitable for separation from the casting when recovered and reused, so as to be favorably reused, may be used.

Please replace paragraph [0049] with the following amended paragraph:

[0049] The gate member 50 has a through gate hole 51. ~~Diameter~~ **The diameter** of the gate hole 51 is made smaller than the diameter of the injection path 80, as a matter of course, and is smaller than the diameter of the billet B. The gate member 50 is fitted in the fitting recess 21 of the die so that the center of the gate hole 51 is located near the center of the cross section of the billet B to be injected.

Page 11, please replace paragraph [0053] with the following amended paragraph:

[0053] The casting that has been taken out is integrated with the gate 50 by the material that is solidified in the gate hole 51. In the case of the thixocasting process **utilizing** cast iron, since the cast iron is white cast iron, the solidified portion of the gate member 50 can be readily split from the casting and therefore the gate 50 can be taken away and reused.

Please replace paragraph [0054] with the following amended paragraph:

[0054] [[An]] **The** embodiment shown in Fig. 2 is a variation of that shown in Fig. 1 with a different configuration of the gate member 50[.] ~~With other regards, ; otherwise~~ the two embodiments are the same and therefore description will be given with identical reference numerals shown in Fig. 2.

Please replace paragraph [0055] with the following amended paragraph:

[0055] In the embodiment shown in Fig. 2, the gate 50 has a projecting portion 52 formed to **project** a certain extent around the gate hole 51 of the gate member 50. The term “certain

extent” means **to** such an extent around the gate hole 51 as the scale formed on the circumference of the billet B is located at a position sufficiently far from the projecting portion 52. In order to cause most of the scale located at the distal end of the billet B to stay in the space around the projection 52, the certain extent described above is set to such a small distance around the gate hole 51 as the effect described above can be achieved.

Please replace paragraph [0056] with the following amended paragraph:

[0056] The projecting portion is sized [[to]] **from** about 2 mm to **about** 10 mm.

Page 12, please replace paragraph [0057] with the following amended paragraph:

[0057] By forming the projecting portion 52 around the gate hole 51 of the gate member 50, the scale formed on the billet B can be prevented from mixing **or** [[()]being entrapped[()]] in the cavity 60.

Please replace paragraph [0058] with the following amended paragraph:

[0058] In order to prevent the scale formed on the billet B from mixing in the cavity 60 during the thixocasting process of the cast iron, it is preferable to cover the circumference of the billet B with a thin sheet of steel that has a melting point higher than that of the billet B. ~~Thickness~~ **The thickness** of the thin steel sheet [[made]] **preferably should** be in a range **of** from 0.2 to **about** 0.5 mm, and preferably from **about** 0.2 to **about** 0.3 mm. The reason for setting this thickness has been described previously.

Please replace paragraph [0062] with the following amended paragraph:

[0062] Table 1 shows chemical components of hypo-eutectic cast iron material used in the thixocasting process of an example. Both Examples and Comparative Examples used billets

that were ~~sampled~~ **taken** from a continuously cast rod of the same batch, ~~[[that]]~~ **and** **therefore** can be regarded as the same material without any substantial variation in the chemical composition.

Page 13, please replace paragraph [0064] with the following amended paragraph:

[0064] The ~~billet measures~~ **billets measured** 75 mm in diameter, 150 mm in length and 5 kg in weight. The same casting conditions for the thixocasting operation were set for Examples and Comparative Examples, except for the injection rate, injection pressure and the billet heating temperature.

Please replace paragraph [0066] with the following amended paragraph:

[0066] In Examples 1 and 2, **the** thixocasting process was carried out by using a flat gate member without **the** projecting portion **described with reference to Fig. 2**. In Examples 3 and 4, **the** thixocasting process was carried out by using a gate member having a projecting portion. Examples 5 and 6 are **the same as** Examples 1 and 2 plus a thin sheet of stainless steel having a thickness of 0.3 mm provided to cover the billet. In Comparative Examples 1 and 2, **the** thixocasting process was carried out without using a gate member. In Comparative Examples 3 and 4, a flat gate member without projecting portion is used and a thin sheet of stainless steel having a thickness of 0.6 mm **was** provided to cover the billet.

Page 16, please replace paragraph [0075] with the following amended paragraph:

[0075] Comparative Examples 3 and 4 are the same as Examples 5 and 6, except for covering the billet with the stainless steel sheet having a thickness of 0.6 mm. In case the

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billet was heated to 1205°C, the covering sheet blocked the gate hole resulting in filling defect. In case the billet was heated to 1220°C, there was a large resistance that strained the covering sheet, thus resulting in filling defect. ~~Sheet~~ **It was concluded that a sheet** thickness of 0.6 mm was too large.

Please delete paragraph [0076].

[0077] The thixocasting process **of the present invention** is capable of manufacturing a part that has a smaller wall thickness and more complicated shape than are possible with the conventional iron casting processes. The thixocasting process can manufacture a part near net shape that has substantially no casting defects such as shrinkage cavity, and is therefore regarded as a promising new iron casting method.

Please add the following new paragraph after paragraph [0077]:

[0078] The foregoing relates to a preferred exemplary embodiment of the invention, it being understood that other variants and embodiments thereof are possible within the spirit and scope of the invention, the latter being defined by the appended claims.